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SPACE TIME DISTRIBUTION OF THE SPORADIC E_s-LAYER AT HIGH LATITUDES

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SPACE-TIME DISTRIBUTION OF THE SPORADIC E_s-LAYER AT HIGH LATITUDES *

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ABSTRACT

A

This paper considers the simultanous apperance of E_s- layer over two groups of high-latitude stations. One group is situated in the Eastern Hemisphere, the other — in the Western Hemisphere. The probability of simultaneous observation of the E_s-layer is so much the higher that the stations are nearer one another in terms of geomagnetic latitude. The sporadic E_s-layers appear simultaneously more often above a surface of $\sim 300 \div 400$ thousand km^2. A dependence is observed between the presence of great critical frequencies of E_s and the rise of H from $200 \div 300\ \gamma$. AUTHOR

* * *

The peculiarities of the space-time distribution of the E_s-layer, considered in the current paper, concern two groups of stations: In the Eastern Hemisphere, 10 stations are involved, namely Inverness ($\Phi = 60{,}6°$), Kiruna ($\Phi = 65{,}3°$), Murmansk ($\Phi = 64{,}1°$), Luleo ($\Phi = 63{,}0°$), Lukzele ($\Phi = 62{,}7°$), Nurmiyarvi ($\Phi = 57{,}9°$), Sodankyül ($\Phi = 63{,}8°$), Tikhaya ($\Phi = 71{,}2°$), Tromse ($\Phi = 67{,}1°$), Upsala ($\Phi = 58{,}6°$), . All these stations are situated in the latitude belt from 57 to 70° N, comparatively close to one another, and mainly around the aurora zone.

* PROSTRANSTVENNO-VREMENNOYE RASPREDELENIYE SPORADICHESKOGO SLOYA E_s V VYSOKIKH SHIRPTAKH.

[redacted]

In the Western Hemisphere tha data of stations situated in the 80 — 90° N latitude range and in Northern Canada — from 68 to 75° N: Alert ($\Phi = 85{,}6$°), Baker Lake ($\Phi = 73{,}8$°), Churchill ($\Phi = 68{,}7$°), Clyde River ($\Phi = 82{,}2$°), Eureka ($\Phi = 83{,}0$°), Fletcher ($\Phi = 82{,}7$°), Godhavn ($\Phi = 79{,}8$°), Resolute Bay ($\Phi = 86{,}3$°), Thule ($\Phi = 88{,}1$°). The particularity of this group of stations is that they are disposed exclusively to the north of the aurora zone to the geomagnetic pole, and they characterize the conditions inside the polar cap. It must be noted that these stations are situated as close together and to one another as is the case for the Eastern Hemisphere.

The basic material for processing consisted in monthly tables of E_s-layer critical frequencies for all the indicated stations. Considered were the hourly values for July, September, December 1957 and for March, June, September and December 1958. The data for every hour were reduced to universal time, which allowed to study the instantaneous picture of sporadic ionization distribution.

The critical frequencies of E_s depend on the technical characteristics of the instrumentation utilized. This dependence hinders the comparison of data from various stations [1, 2]. However, we have been examining the very fact of E_s-layer's existence, rather than the value of the critical frequency. The weaker sporadic ionization, which is not detectable by low-power stations, can be neglected. Thus it may be estimated that no significant effect will be exterted by apparatus' non-uniformity at various stations on the results obtained.

It must be added, that in certain cases we considered the monthly tables for f_{min}, which also depend on the stations' apparatus. But since the presence of total absorption has a quasi-identical effect at various ionospheric stations, while small increases of least frequency of reflection can be neglected, such comparison is possible.

We shall examine the probability of simultaneous observation of the sporadic layer at various stations. Such quantity is conveniently

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calculated relative to the stations detecting the greatest frequency of E_s-layer appearance. All the stations situated in the aurora zone satisfy this requirement. For the Eastern hemisphere we shall consider the coincidence of E_s observations in Murmansk and at any other station situated to the south or to the north of that city. It follows from this analysis, that the probability of E_s-layer appearance is a nearly linear function of the difference $\Delta\Phi$ of geomagnetic latitudes of the station considered and Murmansk, the sign of $\Delta\Phi$ having to be taken into account for the obtention of clear dependence. As to the difference in the geographic longitude distances, it is manifest to a considerably

continuous spectrum
at 750 meters.

The computation data are plotted in Fig. 1. The probability of coinsidence is in the ordinate, and the geomagnetic latitude difference $\Delta\Phi$ is plotted in abscissa.

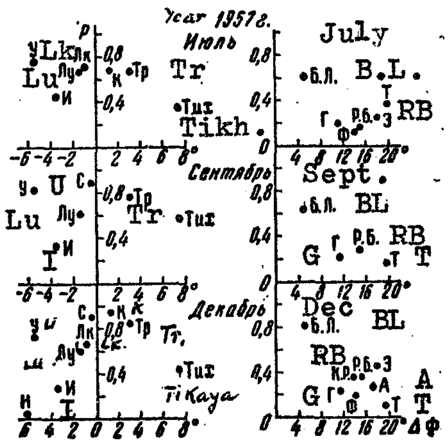

Fig. 1.- The capital letters refer to the various stations of both, the Eastern and the Western Hemisphere, enumerated earlier in the text.

Examination of the graphs for various months shows that they are quite similar. Their characteristic peculiarity consists in that the points for various stations are disposed almost along straight lines. The drop in the direction toward the north is slower than to the south. One stations — Upsala — consitutes an exception, revealing an unusually high percentage of sporadic layers. It is probably linked with the great difference in the emitted power between Upsala and the other stations.

It is interesting to stress, that the Inverness data are complying with the law of linear decrease in the probability of simultaneous observation of the E_s -layer, although this station is not in longitude from the rest of the group. It may be seen from the graph, that at $\Delta\Phi \leqslant 3°$, the probability of simultanous observation of the E_s-layer is not less than 0.6 and often reaches 0.8 to the north of the aurora zone. For the same probability to the south of the aurora zone, $\Delta\Phi \leqslant 2°$. Therefore, it is evident, that the spatial distribution of sporadic ionization is subject to geomagnetic control.

A different pattern is obtained for the Western hemisphere. It is explained by the geographic peculiarities of the considered group of stations. The probabilities of simultaneous observation of E_s are computed relative to Churchill station, which is situated closest to aurora zone and reveals the greatest frequency of E_s- layer appearance. All the remaining stations are situated farther to the north (Fig. 1). At small difference in geomagnetic latitudes ($\Delta\Phi \approx -11°$), the same pattern is repeated in regard to decrease in the probability of simultaneous observation of E_s, as in the Eastern hemisphere.

For example, Godhavn, distant from Churchill by $\Delta\Phi = 11°$, reveals the same probability of E_s observation as Tikhaya station, situated at $7.6°$ to the north of Murmansk. Then, follow stations situated around the geomagnetic pole. In this near-polar zone an increase in the probability of simultaneous E_s-layer observation is noted. In reality, spoardic layers cannot be compared at such distances, and the effect of increase in the probability arises on account of a sharp increase in the frequency of E_s-layer appearance around the geomagnetic pole. The near-polar station Thule does not always observe this effect. In September and December 1957 the frequency of E_s appearance at this station is lower than in the near-polar zone. In the remaining part of the graph, a great ressemblance is observed for various months as for the Eastern hemisphere, and the conclusions derives remain valid. Judging from the data of the Baker Lake station, the probability of simultaneous E_s observation at $\Delta\Phi \leqslant 6°$ is $E_s \geqslant 0.6$.

As may be seen from the preceding examination, the closer is the station by geomagnetic latitude, the greater is the probability of simultaneous existence of the sporadic layer at these stations. If we analyze the data of several stations, we may study the phenomenon over the area encompassed by these stations. It is interesting to examine this question from the standpoint of the surface over which the existence of the sporadic layer is most likely. We shall determine to that effect the frequency of simultaneous observation of E_s by various stations. The calculation is conducted separately for each month in the Eastern and Western hemispheres. The results of computations are plotted in Fig. 2, where the number n of stations, at which the sporadic layer is observed simultaneously is in the abscissa, and the number N of cases of observation is in ordinates. The points correspond to the data for each month (1 — July, 2 — September 1957, 3 — December, 4 — June, 5 — September, 6 — December 1958). Crosses indicate the data for the total absorption, of which there will be question below.

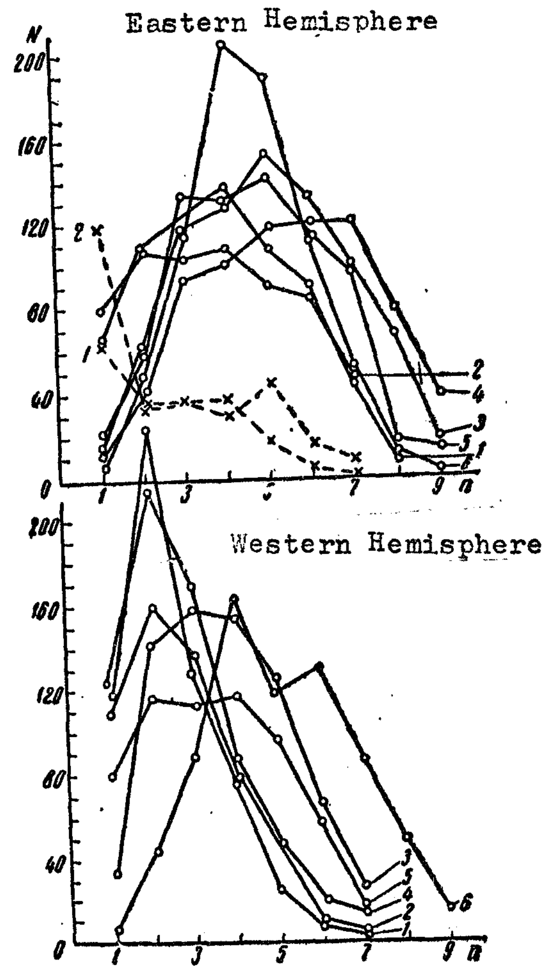

Fig. 2

For the Eastern hemisphere, the simultaneous observation of E_s at 8 — 9 stations is just as of little probability, as it is at 1 — 2; for 4 — 5 stations the simultaneous observation of the E_s-layer is the most probable. For a given geographical situation of the stations, this corresponds to a surface of 300 — 400 thousand km^2, subject to simultaneous effect of the agent responsible for the E_s-layer appearance.

In such case, for the Western hemisphere, where the considered stations are disposed twice as scarcely as in the Eastern hemisphere, the maximum of frequency of E_s observation must be for two stations, which also corresponds to a surface of $\sim 300 \div 400$ thousand km^2.

A detailed calculation can be effected for the number of cases of total absorption B at one, two, three or more stations. (Crosses in Fig. 2, the numbers 1 and 2 respectively designate July 1957 and September 1957). The following is obtained: the smaller is the surface, at which the phenomenon is registered, the greater is the probability of its observation. The total absorption is more often observed at one station; this proves that the total absorption is a smaller-scale phenomenon than the sporadic E_s-layer.. The total absorption is a far less probable phenomenon than the presence of the E_s-layer.

We shall compare the observations of sporadic ionization in the lower ionosphere with the state of the magnetic field at Murmansk. The increase in the ionization in the lower ionosphere layers may be detected by three signs: the presence of E_s, the rise of f_{min} above average level, and the total radiowave absorption.

The comparison of increased ionization in the lower ionosphere layers with the magnetic observatory readings was conducted for separate stations, and in particular for Murmansk [3, 4]. It was then revealed, that for the period of solar activity minimum in the presence of $fE_s \geqslant 4{,}0$ Mc/s, the magnetic field was usually disturbed, [4].

In considering the state of ionization in the lower ionosphere on a surface, encompassed by the whole group of stations, the following rules can be derived:

1. If the sporadic layer is observed at all stations, its critical frequencies reach only $3 \div 4$ Mc/s, seldom 5.0 and never more than 6.0 or more. In all these cases, the amplitude of the horizontal component of the magnetic field failed to exceed $80 \div 100\ \gamma$. Thus, for June 1957, the amplitude was $H = 100\gamma$ in two out of 14 such cases, while the average was of 50γ; for September 1957, the value was somewhat greater. Two cases of H increase from 200 to 300γ corresponded

to the presence of E_s c $fE_s = 7{,}0$ Mc/s.

2. If in the considered area not only the sporadic layer, but also the anomalous absorption is observed, the critical frequencies of E_s reach considerably higher values (9 ÷ 10 Mc/s and more). At the same time, and in relation to the fact as to whether the total absorption will be observed over Murmansk or not, the value of H will either be high (sometimes 400 — 700 γ) or low. There are some exceptions, but they are seldom encountered.

Therefore, two degrees of ionization intensity are encountered in the lower ionosphere. One, the lower, is revealed in the observation of small, critical-frequency-wise sporadic layers and is not attended by variations of the magnetic field. The second, higher one, is revealed in the presence of E_s with great critical frequencies, in the total absorption at some stations, and is attended by amplitude increase of the horizontal component of the magnetic field.

****** THE END ******

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